ARMY RESEARCH LABORATORY

Methodology for Performing a Manpower and Personnel Integration (MANPRINT) Evaluation for U.S. Army Systems

by Teresa A. Branscome

ARL-TR-6310 **January 2013**

NOTICES

Disclaimers

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5425

ARL-TR-6310 **January 2013**

Methodology for Performing a Manpower and Personnel Integration (MANPRINT) Evaluation for U.S. Army Systems

Teresa A. Branscome
Human Research and Engineering Directorate, ARL

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED (From - To)
January 2013	Final	

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Methodology for Performing a Manpower and Personnel Integration (MANPRINT) Evaluation for U.S. Army Systems	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)	5d. PROJECT NUMBER
Teresa A. Branscome	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
U.S. Army Research Laboratory ATTN: RDRL-HRM-B Aberdeen Proving Ground, MD 21005-5425	ARL-TR-6310

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The U.S. Army Research Laboratory's (ARL's) Human Dimension Major Laboratory Program (MLP) is a major Army effort designed to support evaluations of the integration between Soldiers and communications systems, weapons, and vehicles (U.S. Army Research Laboratory. *FY12 Annual Performance Plan*; Aberdeen Proving Ground, MD, 2012). Under this MLP, the Human Research and Engineering Directorate is responsible for the development of MANPRINT (Manpower and Personnel Integration) evaluations of the systems, which include assessment method development, evaluations of Soldier-system design, and Soldier performance assessments during each life cycle phase to make certain Soldiers are equipped with systems they can operate proficiently with minimal risk.

A major objective of this effort has been to develop and execute a systems engineering approach along with standardized field-operational Soldier performance metrics to quantify and validate integrated Soldier-information systems performance on the digital battlefield. One component of this approach is the development of an evaluation methodology to quantify and evaluate Soldier-information systems performance, which is the focus of this report.

15. SUBJECT TERMS

MANPRINT methodology, situation awareness, workload, Soldier-system design, systems engineering, Soldier information

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Teresa A. Branscome
Unclassified	Unclassified	Unclassified	UU	40	19b. TELEPHONE NUMBER (*Include area code*) 410-278-5951

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Contents

INTENTIONALLY LEFT BLANK.

1. Introduction

To increase readiness and capabilities, the U.S. Army is constantly introducing newly evolving weapons and technology systems. However, in doing so, actual system performance does not always meet expectations. Additionally, the replacement or product improvement of existing systems often requires additional training, skills, or Soldiers to operate, maintain, and support the systems. This, in turn, would require recruiting more highly skilled Soldiers, additional training and training expenses, and an overall expansion of Army training programs. Moreover, increases in system complexity impact mobilization, readiness, and sustainability. Design details and human performance of emerging systems have a significant impact on these factors.

One of the U.S. Army Research Laboratory's (ARL's) Major Laboratory Programs (MLP), Human Dimension (HD), was conceived to address these issues. This MLP, which was formalized by the U.S. Army Training and Doctrine Command, is a major Army effort designed to support evaluations of the integration between Soldiers and communications systems, weapons, and vehicles (U.S. Army Research Laboratory, 2012).

The Human Research and Engineering Directorate (HRED) is the lead organization for the HD MLP. Under this MLP, HRED is responsible for evaluating Soldier-system performance to make certain Soldiers are equipped with systems they can operate proficiently with minimal risk. This responsibility includes the development of MANPRINT (Manpower and Personnel Integration) evaluations of the systems, which include assessment method development, evaluations of Soldier-system design, and Soldier performance assessments.

To ensure that these issues are considered within system development during each life cycle phase, these evaluations are performed during the System Acquisition Process. These evaluations are used to influence the Milestone Decision Review process that determines whether or not the system is ready to transition to the next scheduled phase.

MANPRINT (The MANPRINT Mission, 2001) is a comprehensive management domain designed to optimize total system performance, reduce life cycle costs, and minimize risk of Soldier loss or injury by focusing on human requirements and considering the impact of materiel design on Soldiers throughout the system development process. A major thrust of MANPRINT is to identify man-machine interface issues which, taken individually or collectively, may be so objectionable that, if not remedied, would warrant a decision not to transition into the next phase.

Identifying and rectifying these issues is achieved by thorough investigation of the following seven MANPRINT domains:

1. **Manpower** – This domain assesses the number of military and civilian personnel required to operate, maintain, sustain, and provide training for systems and ensures that total manpower requirements lie within Army constraints and resource demands of the system do not exceed the available supply.
2. **Personnel** – This domain assesses the cognitive and physical capabilities required to be able to train for, operate, maintain, and sustain materiel and information systems.
3. **Training** – This domain assesses the instruction and on-the-job or unit training required to provide personnel with essential job skills, knowledge, and abilities. It ensures that the amount and content of training will allow Soldiers to acquire the skills necessary to accomplish their tasks.
4. **Human Factors Engineering** – This domain assesses the integration of human characteristics into system definition, design, development, and evaluation to optimize human-machine performance under operational conditions. Considerations of this domain include making the equipment easier to operate, maintain, and support; reducing the time required to complete tasks; reducing operator error; and reducing time and money spent on training.
5. **System Safety** – This domain assesses the design features and operating characteristics of a system that minimize the potential for human or machine errors or failures that may cause accidents or injuries and ensures that those measures are designed into the total system.
6. **Health Hazards** – This domain assesses the design features and operating characteristics of a system that create significant risks of bodily injury or death including acoustics, biological and chemical substances, temperature extremes and variations, radiation, oxygen deficiency, shock (not electrical), trauma, and vibration.
7. **Soldier Survivability** – This domain assesses the characteristics of a system that can reduce fratricide, detectability, and probability of being attacked and minimize system damage, Soldier injury, and cognitive and physical fatigue.

Throughout the design and development phases, MANPRINT ensures that the system operation, maintenance, training, and support requirements are matched to personnel availability and capability; systems are increasingly user-friendly, reliable, and maintainable; and system performance is optimized at minimal life cycle costs.

2. Methodology

The integration team of the MANPRINT Methods and Analysis Branch (MMAB), HRED, is responsible for providing MANPRINT evaluation support to the U.S. Department of Defense (DOD) on acquisition programs. These evaluations serve to optimize system performance and minimize life-cycle costs, ensuring that Soldier and organizational needs are considered throughout the system acquisition process and are integrated into the system design while adhering to U.S. Army Regulation (AR) 602-2 (2001).

A major objective of this effort has been to develop and execute a systems engineering approach along with standardized field-operational Soldier performance metrics to quantify and validate integrated Soldier-information systems performance on the digital battlefield. This approach consists of three steps: (1) identifying tasks and behavioral characteristics associated with effective mission command performance at operator, staff, and organizational levels; (2) developing a framework for measuring the usability, functionality, and performance of the technology; and (3) developing an evaluation methodology to quantify and evaluate Soldier-information systems performance, which is the focus of this report (Grynovicki and Branscome, to be published).

2.1 Procedures

MMAB MANPRINT assessments strive to focus on the Soldiers by talking to them, determining what they want and need, and ensuring they are adequately trained to perform their mission. This is achieved by employing multiple evaluation methods to ensure that the Soldiers are adequately trained to perform their mission and that the equipment is easy to operate, maintain, and support, while possibly reducing the time to accomplish tasks, the chance for operator error, the amount of training needed, or the need for special skills. These evaluation methods include observations, questionnaires, and interviews and are normally performed during or after training and during or after task execution.

2.1.1 Observations

Observation methods commonly employed include heuristic walk-throughs and over-the-shoulder observations. These entail subject matter experts examining training, procedures, and job tasks in an operational setting and making recommendations based on key usability principles and functionality tasks. When space considerations allow, HRED practitioners attend and/or engage in actual full equipment training, including classroom and hands-on training. This allows first-hand knowledge of the system and opportunities for interacting with instructors as well as users. Evaluators need to observe the training in the field and talk with Soldiers to find out how well the system met their needs and to identify any issues they had with the system.

Observations in operational settings allow evaluators to see first-hand how well the operators were trained on the system and determine if additional training would be required. Additionally, it affords us the opportunity to examine the system's ability to provide accurate situational understanding and support the job tasks of the Soldier so they can complete their mission.

2.1.2 Questionnaires

Generally, questionnaires are distributed after classroom training, hands-on training, and during or after practical exercises. They normally consist of closed-ended questions and Likert scales based on key factors and previously defined systems requirements. Question items can be general or system-specific. Questionnaire responses are analyzed to obtain the Soldiers' overall opinions, recommendations, and concerns.

An example of general questions may be as follows:

Place an X in the appropriate box:	Totally Agree	Agree	Neither Agree nor Disagree	Disagree	Totally Disagree	NA
The system is well designed.	—	—	—	—	—	—
The system is reliable.	—	—	—	—	—	—
The system is easy to operate.	—	—	—	—	—	—

Whereas, an example of system-specific questions may be as follows:

Place an X in the appropriate box:	Totally Agree	Agree	Neither Agree nor Disagree	Disagree	Totally Disagree	NA
It was easy to use the ABC switch to enable/disable system access.	—	—	—	—	—	—
Plotting IED locations was easy, timely and accurate.	—	—	—	—	—	—

A complete sample questionnaire is included in appendix A.

2.1.3 Metrics

Additionally, a select battery of validated metrics is used to measure and quantify the effects of workload, situation awareness, and individual differences on total Soldier performance during the MANPRINT evaluations. These metrics include standardized measures with demonstrated construct validity that allow us to collect qualitative and quantitative data to further evaluate the systems in terms of usability and to support the overall MANPRINT assessment.

2.1.3.1 Workload. Subjective ratings of mental and physical workload provide evaluators with the operators' opinions on the amount of effort required to perform tasks. This information is vital in determining the amount of reduction in performance that may be attributed to increases in workload.

The National Aeronautics and Space Administration-Task Load Index (NASA-TLX) (Hart and Staveland, 1988) is an evaluation of the relative importance of six factors in determining how much workload an individual experiences during a specific task. These factors—mental demand, physical demand, temporal demand, performance, effort, and frustration level—are presented as a series of pairs. The participant is asked to choose which item is more important to his or her experience of workload during the task. Choice patterns are used to create weighted combination ratings that determine summary workload scores. Operators are then asked to rate their average workload experienced during the mission or after individual tasks. Resultant ratings aid researchers in evaluating the ease-of-use and suitability of the interface. The NASA-TLX has been used in evaluations of the Force XXI Battle Command Brigade and Below (FBCB2) (U.S. Army Evaluation Center, 2011), Future Combat Systems (FCS) Integrated Mission Test I (IMT1) (U.S. Army Test and Evaluation Center, 2007), and Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance systems. The NASA-TLX is included in appendix B.

The Modified Cooper-Harper (MCH) scale is used to rate operator demand level. This scale is a 10-point rating scale that results in a single rating of workload (Hill et al., 1992). This modification of the Cooper-Harper scale allows analysts to apply it to Soldier-information systems to evaluate how well the operator processes display information and identify deficiencies in operator interfaces. Most commonly, the MCH is used in evaluating operator interfaces for unmanned vehicles, such as the Rabbit 2.0 system (Scribner et al., to be published). A variation of the MCH is included in appendix C.

The Situation Awareness Rating Technique (SART) (Taylor, 1990) provides researchers with the operators' subjective opinions on their workload level on individual tasks. It is useful in operational environments because it is easy to use and administer in diversified environments.

Operators rate the demand on their resources, supply of their resources, and their understanding of the situation on a 7-point scale from "very low" to "very high." The resulting scores are then scaled to provide the evaluator with a single rating of overall workload. This methodology was also used successfully in the FCS IMT1. The Situation Awareness Rating Technique is included in appendix D.

2.1.3.2 Situation Awareness. Situation Awareness (SA) is a three-level concept: (1) knowing what is going on in the environment (perception), (2) understanding the meaning of what is going on (comprehension), and (3) predicting what will happen in the future based on the current situation (projection). By including SA analyses during the MANPRINT evaluation process, we are able to increase system usability and enhance human factors engineering (HFE).

SA assessment metrics provide us with objective and subjective data on how operators and Soldiers obtain, comprehend, and act on information and allow us to formulate system and informational requirements. The Situation Awareness Global Assessment Technique (SAGAT)

(Endsley, 2000) is used to measure operator SA requirements during task execution. This tool allows evaluators to temporarily stop the simulation or task and query operators about their current awareness of the situation. In turn, the operators' SA can then be compared to ground truth to provide an objective measure of SA. SAGAT questions are customized to the system being evaluated. Examples of SA queries may be found in appendix E.

Situation Awareness Behaviorally Anchored Rating Scale (Endsley, 1995) is an objective measurement tool often used in conjunction with SAGAT. Evaluators use this tool to observe and rate an individual's behaviors as they relate to SA and to gain insights into the techniques and strategies used by the operators. The tool consists of 28 items that have been identified as being significant contributors to successful SA and are rated on a 5-point scale.

2.1.4 Interviews

Interviews are structured or informal discussion/question and answer sessions with Soldiers, key staff leaders, and users. When feasible, practitioners engage in off-the-cuff dialogue with users during training and task execution. When that is not practical, interviews are usually afforded during After Action Reviews (AAR). An AAR is a professional discussion between developers, operators, and researchers conducted after an assessment or evaluation. This forum allows researchers the opportunity to engage in discussions with operators, maintainers, and developers to determine their insights and specific opinions, recommendations, and concerns.

Interviews are an integral component of the overall assessment in that they allow the researchers to ask what happened during task execution, why certain events happened, and how improvements can be made to the system to alleviate problems and strengthen weaknesses. We use these opportunities to identify tasks or procedures that require additional or remedial training; suggest adjustments or improvements to the training materials; make recommendations for system improvements or modifications; recommend solutions for improving HFE and usability; and identify lessons learned so they can be applied to future applications.

3. Analysis and Recommendation

Upon analysis of evaluation data, issues, ratings, and recommendations for each MANPRINT domain are provided. An issue can impact one or more domains; however, it is normally only addressed under the domain for which it has the greatest impact. A critical issue is a system characteristic which, if not remedied, could possibly result in death or bodily injury, termination of the mission, loss of the system, inability of the system to perform its intended mission, or an unacceptable impact on the manpower, personnel, or training requirements of the system. A major issue is a system characteristic which, if not remedied, could possibly result in bodily injury, reduced mission performance, extensive system damage, seriously diminished capacity of the system to perform its intended mission, or a significant negative impact on the manpower,

personnel, or training requirements of the system. A concern is a system characteristic which, if not remedied, could possibly result in discomfort to the Soldier, reduced mission effectiveness, or system damage. The color ratings by domain are made by the ARL-HRED MANPRINT practitioner. A rating of green indicates that the system is ready to transition to the next level; a rating of amber indicates that the system has minor problems that should be addressed but are not serious enough to prevent the system to be transitioned to the next level; and a rating of red indicates that the program must be stopped until the issue is resolved.

Based on findings, recommendations for changes or system improvements are offered by the practitioner. Recommendations include, but are not limited to, the following:

1. Assessing and determining true manpower and personnel requirements and ensuring that those needs lie within Army constraints.
2. Providing suggestions for enhanced training methodologies and improvements to training materials and ensuring that the system is designed for the target population. This includes a determination of how much and what type of training is necessary to provide Soldiers with the skills necessary to successfully complete their tasks.
3. Determining improved operational characteristics of the system under consideration, including controls, displays, the man-machine interface, and the operational and environmental setting in which the system is operated.
4. Suggesting improved design features and tactics, techniques, and procedures for system employment to minimize the risk of potential human error, system malfunction, mental and physical fatigue, Soldier detectability, injury, fratricide, and vulnerabilities to man and machine.

4. Technology Transition

One of the technical objectives of the HD MLP is for ARL to develop tools and analytic methodologies for providing MANPRINT criteria early in the acquisition lifecycle. In support of that objective, MMAB is currently involved with the development of the Metrics of Global Assessment and Situation Awareness (MEGA-SA) (Bolstad, 2011) data collection tool. This tool is based on the SAGAT method of evaluation and will allow researchers or evaluators to obtain objective measures of SA in real time at all levels (perception, comprehension, projection) as well as to evaluate training. MEGA-SA is a user-friendly tool that will be used in laboratory and field evaluations. It will provide researchers with a means to develop customized objective SA assessments across Army command and control systems.

Evaluators are capable of customizing assessments to meet the system's training and performance objectives and will be able to include other metrics for SA and workload such as NASA-TLX as well as customized post-task questionnaires.

MEGA-SA is composed of four modules: Metric Tool, Setup Tool, Run Tool, and Report Tool. The Metric Tool allows users to create a database of metric items, response items, and metric sets to be used during a specific evaluation. With the Setup Tool, evaluators can define metric events and schedule those events for specific or random times during the evaluation. It allows the user to determine how the queries will be presented (visual or auditory), who the queries will be presented to, how often the queries will be presented, how the queries are triggered (e.g., time stamp, location, or event), and how the operator is expected to respond to the queries. The Run Tool allows users to manage and monitor the events and monitor the network. Lastly, the Report Tool creates reports, analyzes the data, and exports the data and related graphics.

The MEGA-SA tool will be an invaluable addition to the MANPRINT evaluation process as it will provide MANPRINT practitioners with a flexible customizable tool that will increase the robustness of Army systems evaluations. This tool will be adaptable to all domains throughout the DOD.

5. Conclusion

This report described the methodology used by the MANPRINT MMAB, ARL/HRED, in performing MANPRINT Soldier-machine evaluations during the system acquisition process. This global-based approach has been used successfully in evaluations of many Army systems. ARL-HRED supported the U.S. Army Test and Evaluation Center during the rapid equipment fielding of the Persistent Surveillance Dissemination System of Systems capability demonstration. Quantitative and qualitative data analyses using the methods described in this report lead to an increased capability to integrate data-feed from imaging sensors as well as improvements in situational awareness.

Other major systems evaluated with this method include the General Fund Enterprise Business System, Common Remotely Operated Weapon Station, and Net-Centric Enterprise Services, among others. By combining observation, interview, and questionnaire evaluation methods, including standardized metrics for assessing SA and workload, we are able to provide the project manager with recommendations and establish system requirements throughout the design and development phases, thus alleviating extraneous cost and time.

6. References

Bolstad, C. A. *Situation Awareness Assessment Tools for Network Enabled Command and Control Field Evaluations*; contract number W911QX-10-C-0083; U.S. Army Research Laboratory: Aberdeen Proving Ground, MD, 2011.

Endsley, M. R. Measurement of Situation Awareness in Dynamic Systems. *Human Factors* **1995**, *37* (1), 65–84.

Endsley, M. R. Direct Measurement of Situation Awareness: Validity and Use of SAGAT. In *Situation Awareness Analysis and* Measurement; Endsley, M. R., Garland, D. J., Eds.; Erlbaum: Mahwah, NJ, 2000; pp 147–173.

Grynovicki, J. O.; Branscome, T. A. Systems Engineering Approach and Metrics for Evaluating Digitization for U.S. Army Battle Command. U.S. Army Research Laboratory: Aberdeen Proving Ground, MD, to be published.

Hart, S. G.; Staveland, L. E. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In *Human Mental Workload*; Hancock, P. A., Meshkati, N., Eds.; Elsevier, Amsterdam, 1988; pp 139–184.

Hill, S. G.; Lavecchia, H. P.; Byers, J. C.; Bittner, A. C.; Zaklad, A. L.; and Christ, R. E. Comparison of 4 Subjective Workload Rating-Scales. *Human Factors* **1992**, *34* (4), 429–439.

Scribner, D. R.; Animashaun, A.; Culbertson, W. Soldier Performance in a Moving Command Vehicle Under Manned, Teleoperated, and Teleoperated Cruise Control Modes Under Day and Night Conditions; to be published.

Taylor, R. M. Situational Awareness Rating Technique (SART): The Development of a Tool for Aircrew Systems Design. *In Situational Awareness in Aerospace Operations (AGARD CP 478*); Neuilly Sur Seine, France, 1990; pp 3/1–3/17.

The MANPRINT Mission. http://www.manprint.army.mil/manprint/domains.html (accessed 2001).

U.S. Army Evaluation Center. Force XXI Battle Command Brigade and Below – Joint Capability Release (FBCB2-JCR w/BFT1 v1.3.1), 2011.

U.S. Army Regulation (AR) 602-2. *Manpower and Personnel Integration (MANPRINT) in the System Acquisition Process* **2001**.

U.S. Army Research Laboratory. *FY12 Annual Performance Plan*; Aberdeen Proving Ground, MD, 2012.

U.S. Army Test and Evaluation Command. U.S. Army Test and Evaluation Command System Assessment Plan, Future Combat Systems (FCS) Integrated Mission Test (IMT) 1, 2007.

Appendix A. Sample Manpower and Personnel Integration Questionnaire

This appendix appears in its original form, without editorial change.

Instructions

The purpose of this questionnaire is to collect training information on the system. Your answers will be treated confidentially and will not be shown to anyone except those who are evaluating the system for the Army. None of your information will be given to your chain of command or put in your personnel file. Please fill out the questionnaire carefully. If you need additional space to answer a question, indicate by an arrow (→) and continue on the back of the page. Please be sure to number the item on the back of the page. If you have any questions please contact a test team representative for help. Thank you for your assistance

1) Date: ___ ___ / ___ ___ ___ / ___ ___
(DD/MMM/YY Example: 01 Sep 11)

2) PIN: _____
(Assigned by test team)

3) Grade _____

4) Primary MOS _____

5) Time in Primary MOS _____

6) Current duty position _____

7) Time in current duty position _____

MANPOWER & PERSONNEL

Answer the following **Manpower & Personnel** questions:

(place an X in the appropriate box)	Yes	No
a) Is your skill level adequate to effectively operate the system? *(If no, please comment.)*		
b) Is your skill level adequate to effectively maintain the system? *(If no, please comment.)*		
c) Is your skill level adequate to effectively perform the mission? *(If no, please comment.)*		
d) Do the personnel skills required to set up and operate the system necessitate a specific Additional Skills Identifier (ASI) or MOS? (*If yes, please comment)*		
e) Did you require additional personnel to set up and operate the system? (*If yes, please comment)*		

Comments:

_____

_____

_____

The number of operators allocated to perform the installation/operation tasks is/are adequate.

Completely Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Completely Agree

If you disagree at all, please explain.

_____

Soldiers operating this system will need a specific MOS or Additional Skill Identifier (ASI).

	Completely Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Completely Agree
Operate						
Maintain						

TRAINING

Rate the **operator classroom training** using the scale below:

(place an X in the appropriate box)	Very Poor	Poor	Acceptable	Good	Very Good	NA
Length of training.						
Pace of training.						
Clarity of text.						
Completeness.						
Accuracy.						
Logical sequence.						
Ease of reading.						
Ease of use.						
The user manuals and training handouts were easy to understand and organized in a manner that enabled me to find information quickly.						
The technical and/or user manuals adequately describe how to install and operate the system.						

Comments:_____
_____

Rate the **hands-on training** using the scale below and provide comments.

(If you did not receive training, check here _____ and go to the next question)

(place an X in the appropriate box)	Very Poor	Poor	Acceptable	Good	Very Good	NA
Completeness						
Accuracy						
Logical sequence						
Installation of system						
Operation and control of system						
Practical exercises						
The pace at which the new material presented.						
Upon completion of training, I feel confident in my ability to complete my basic mission.						
Overall length of training.						
Overall quality of training						

Training Comments:

_____

_____

_____

Did the classroom/hands-on training address safety issues associated with the AHD?

_____

If no, please comment.

_____

The training enabled me to effectively setup, restore/repair, operate, troubleshoot, maintain, shutdown or request assistance when required.

	Completely Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Completely Agree
Setup/ Startup						
Restore/ Repair						
Operate						
Troubleshoot						
Maintain						
Request Assistance						

If you disagree with any topic(s), please explain.

_____

_____

The technical manual (TM) contained just the right amount of information to enable me to complete my tasks.

Completely Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Completely Agree

If you disagree, please explain.

_____

_____

The TM was accurate and contained the proper task execution order that enabled me to troubleshoot, diagnose and complete my tasks in an organized and thorough manner.

	Completely Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Completely Agree
Troubleshoot						
Fault Isolate						
Repair/Replace						

If you disagree at all, please explain.

_____

_____

What specific areas of training could be improved, and how (i.e. more detailed explanation, etc.)?

_____

_____

HFE (Human Factors Engineering)

Rate the following HFE characteristics.

(place an X in the appropriate box)	Very Poor	Poor	Acceptable	Good	Very Good	NA
Ability to start the system.						
Ability to use the x control.						
Ability to use the y control.						
System response time						
Size of displays appropriate for intended usage						
Visibility of all displays during day operations.						
Visibility of all displays during night operations.						
Shape of displays appropriate for intended usage.						
Illumination of displays (screen brightness/contrast).						
Viewing angle of displays.						
Use of displays when wearing corrective lenses.						

While using the system did you experience any of the following?

(place an X in the appropriate box)	Yes	No	NA
a) Eye strain? *(If yes, please comment.)*			
b) Tunnel vision? *(If yes, please comment.)*			
c) Motion sickness? *(If yes, please comment.)*			
d) Headaches? *(If yes, please comment.)*			
e) Dizziness? *(If yes, please comment.)*			
f) Disorientation? *(If yes, please comment.)*			
g) Fatigue? *(If yes, please comment.)*			
h) Glare? *(If yes, please comment.)*			
i) Other? *(If yes, please comment.)*			
j) Did you identify any potential safety or health hazards that may have posed a threat to you or anyone else around you? *(If yes, please comment.)*			

Comments:_____

_____

_____

Survivability, Safety, and Health Hazards

Rate the system design for **Survivability, Safety, and Health Hazard** characteristics using the scale

below.

(place an X in the appropriate box)	Totally Agree	Agree	Neither Agree nor Disagree	Disagree	Totally Disagree	NA
a) Light emissions pose no survivability risk to me on the battlefield.						
b) Noise emissions pose no survivability risk to me on the battlefield.						
c) Overall, the system has no adverse impact on my survivability in combat.						
d) The system is safe to operate.						
e) The system does not have any health hazards associated with it.						

Comments:_____

_____

_____

Rate the overall system using the scale below.

(place an X in the appropriate box)	Totally Agree	Agree	Neither Agree nor Disagree	Disagree	Totally Disagree	NA
a) Overall, the system enhances my ability to complete my mission.						
b) Overall, the system is well designed and is easy to operate.						
c) The system is reliable.						
d) I would not hesitate to take the system into combat as it is currently configured.						

Comments:

_____

INTENTIONALLY LEFT BLANK.

Appendix B. National Aeronautics and Space Administration-Task Load Index (NASA-TLX) Workload Questionnaire

This appendix appears in its original form, without editorial change.

NASA-TLX Workload Questionnaire

For each pair, select the one element that is more important for measurement of workload for the task.

☐ Mental Demand	/	Physical Demand	☐
☐ Mental Demand	/	Temporal Demand	☐
☐ Physical Demand	/	Temporal Demand	☐

NASA-TLX RATING SCALE DEFINITIONS

MENTAL DEMAND *Low/High* How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?

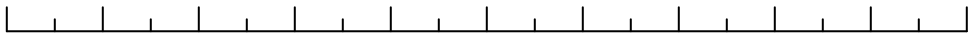
PHYSICAL DEMAND *Low/High* How much physical activity was required (e.g.. pushing, pulling, turning, controlling, activating,, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous restful or laborious?

TEMPORAL DEMAND *Low*/High How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

NASA-TLX Workload Questionnaire

For each workload element listed below, please indicate (with an exact mark on the line) how much each element contributed to your overall workload experienced in the task you just performed. Please write the corresponding number for your mark in the space provided below each line.

Mental Workload

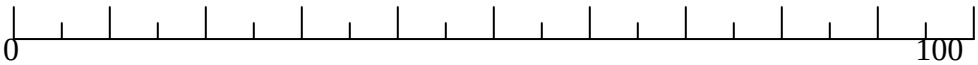


0 100

Low High

What number is this?_____

Physical demand

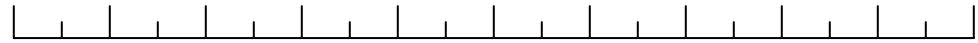


0 100

Low High

What number is this?_____

Temporal Demand



0 100

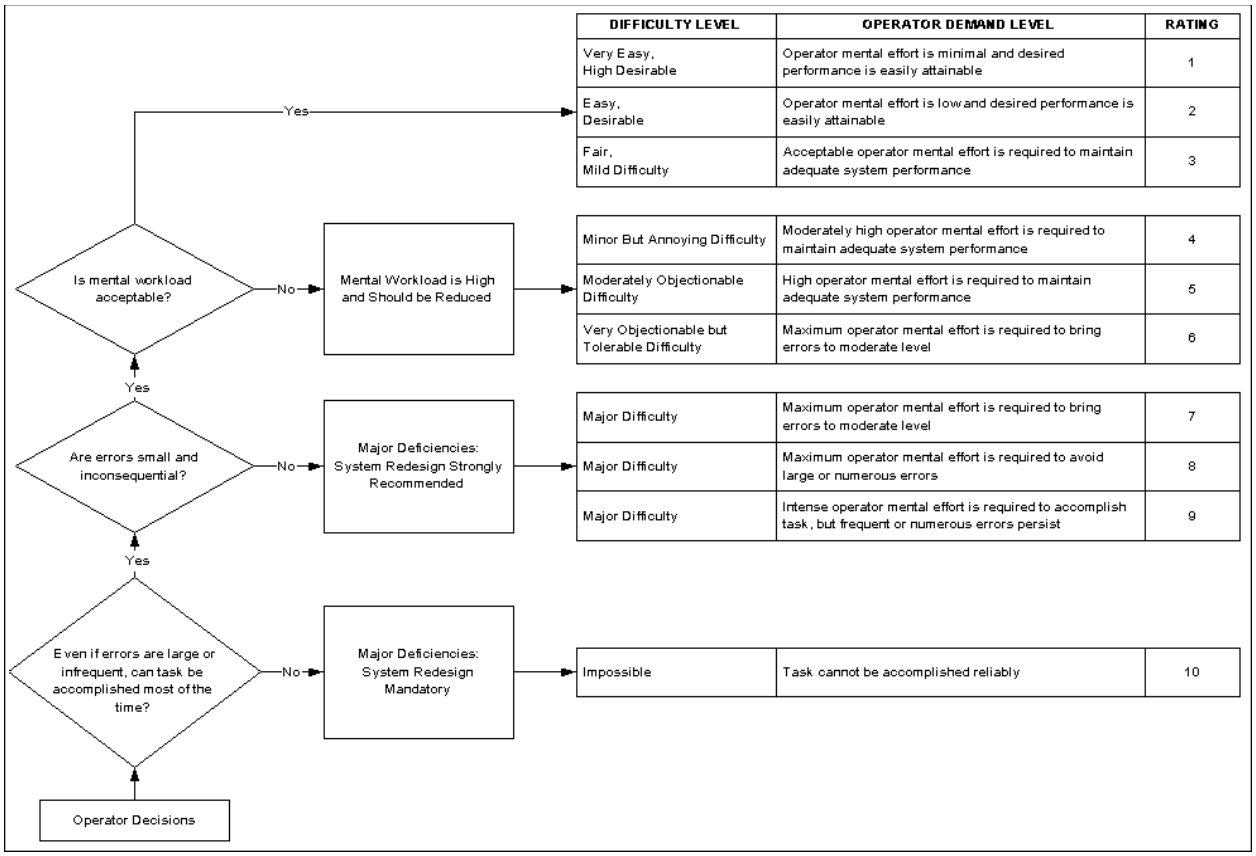
Low High

What number is this?_____

INTENTIONALLY LEFT BLANK.

Appendix C. Modified Cooper-Harper

This appendix appears in its original form, without editorial change.



DIFFICULTY LEVEL	OPERATOR DEMAND LEVEL	RATING
Very Easy, High Desirable	Operator mental effort is minimal and desired performance is easily attainable	1
Easy, Desirable	Operator mental effort is low and desired performance is easily attainable	2
Fair, Mild Difficulty	Acceptable operator mental effort is required to maintain adequate system performance	3
Minor But Annoying Difficulty	Moderately high operator mental effort is required to maintain adequate system performance	4
Moderately Objectionable Difficulty	High operator mental effort is required to maintain adequate system performance	5
Very Objectionable but Tolerable Difficulty	Maximum operator mental effort is required to bring errors to moderate level	6
Major Difficulty	Maximum operator mental effort is required to bring errors to moderate level	7
Major Difficulty	Maximum operator mental effort is required to avoid large or numerous errors	8
Major Difficulty	Intense operator mental effort is required to accomplish task, but frequent or numerous errors persist	9
Impossible	Task cannot be accomplished reliably	10

Appendix D. Situation Awareness Rating Technique

This appendix appears in its original form, without editorial change.

SA1. Situation Awareness is defined (simplistically) as "timely knowledge of what is happening as you perform your tasks during the mission."

Situation Awareness Rating Technique (SART)	
DEMAND	
Instability of Situation	Likeliness of situation to change suddenly
Variability of Situation	Number of variables which require your attention
Complexity of Situation	Degree of complication (number of closely connected parts) of the situation
SUPPLY	
Arousal	Degree to which you are ready for activity
Spare Mental Capacity	Amount of mental ability available to apply to new tasks
Concentration	Degree to which your thoughts are brought to bear on the situation
Division of Attention	Amount of division of your attention in the situation
UNDERSTANDING	
Information Quantity	Amount of knowledge received and understood
Information Quality	Degree of goodness or value of knowledge communicated
Familiarity	Degree of acquaintance with the situation

Rate the level of each component of situation awareness that you had when you performed 'offensive position' tasks as part of your unit that you just completed. Circle the appropriate number for each component of situation awareness (e.g., complexity of situation) using the aforementioned definitions.

DEMAND

Instability of situation: Low 1---------2---------3---------4---------5---------6---------7 High

Variability of situation: Low 1---------2---------3---------4---------5---------6---------7 High

Complexity of situation: Low 1---------2---------3---------4---------5---------6---------7 High

---

SUPPLY

Arousal:	Low	1---------2---------3---------4---------5---------6---------7	High
Spare mental capacity:	Low	1---------2---------3---------4---------5---------6---------7	High
Concentration:	Low	1---------2---------3---------4---------5---------6---------7	High
Division of attention:	Low	1---------2---------3---------4---------5---------6---------7	High

---

UNDERSTANDING

Information quantity:	Low	1---------2---------3---------4---------5---------6---------7	High
Information quality:	Low	1---------2---------3---------4---------5---------6---------7	High
Familiarity:	Low	1---------2---------3---------4---------5---------6---------7	High

INTENTIONALLY LEFT BLANK.

Appendix E. Sample Situation Awareness Questions

This appendix appears in its original form, without editorial change.

1. What is the status of the platoon sensors?

_____
_____
_____

2. On the map plot the threat mortar location.

3. What is the most significant threat to your force at this time?

_____
_____
_____

4. What action will the enemy take in the next 15 minutes?

_____
_____
_____

NO. OF COPIES	ORGANIZATION
1 (PDF only)	DEFENSE TECHNICAL INFORMATION CTR DTIC OCA 8725 JOHN J KINGMAN RD STE 0944 FORT BELVOIR VA 22060-6218
1	DIRECTOR US ARMY RESEARCH LAB IMAL HRA 2800 POWDER MILL RD ADELPHI MD 20783-1197
1	DIRECTOR US ARMY RESEARCH LAB RDRL CIO LL 2800 POWDER MILL RD ADELPHI MD 20783-1197

NO. OF
COPIES ORGANIZATION

1 ARMY RSCH LABORATORY – HRED
RDRL HRM C A DAVISON
320 MANSCEN LOOP STE 115
FORT LEONARD WOOD MO 65473

2 ARMY RSCH LABORATORY – HRED
RDRL HRM DI
T DAVIS
J HANSBERGER
BLDG 5400 RM C242
REDSTONE ARSENAL AL 35898-7290

1 ARMY RSCH LABORATORY – HRED
RDRL HRS EA DR V J RICE
BLDG 4011 RM 217
1750 GREELEY RD
FORT SAM HOUSTON TX 78234-5002

1 ARMY RSCH LABORATORY – HRED
RDRL HRM DG K GUNN
BLDG 333
PICATINNY ARSENAL NJ 07806-5000

1 ARMY RSCH LABORATORY – HRED
ARMC FIELD ELEMENT
RDRL HRM CH C BURNS
THIRD AVE BLDG 1467B RM 336
FORT KNOX KY 40121

1 ARMY RSCH LABORATORY – HRED
AWC FIELD ELEMENT
RDRL HRM DJ D DURBIN
BLDG 4506 (DCD) RM 107
FORT RUCKER AL 36362-5000

1 ARMY RSCH LABORATORY – HRED
RDRL HRM CK J REINHART
10125 KINGMAN RD BLDG 317
FORT BELVOIR VA 22060-5828

1 ARMY RSCH LABORATORY – HRED
RDRL HRM AY M BARNES
2520 HEALY AVE
STE 1172 BLDG 51005
FORT HUACHUCA AZ 85613-7069

1 ARMY RSCH LABORATORY – HRED
RDRL HR MP D UNGVARSKY
POPE HALL BLDG 470
BCBL 806 HARRISON DR
FORT LEAVENWORTH KS 66027-2302

NO. OF
COPIES ORGANIZATION

1 ARMY RSCH LABORATORY – HRED
RDRL HRM AT J CHEN
12350 RESEARCH PKWY
ORLANDO FL 32826-3276

1 ARMY RSCH LABORATORY – HRED
RDRL HRM AT C KORTENHAUS
12350 RESEARCH PKWY
ORLANDO FL 32826

1 ARMY RSCH LABORATORY – HRED
RDRL HRM CU
6501 E 11 MILE RD MS 284
BLDG 200A 2ND FL RM 2104
WARREN MI 48397-5000

1 ARMY RSCH LABORATORY – HRED
FIRES CTR OF EXCELLENCE
FIELD ELEMENT
RDRL HRM AF C HERNANDEZ
3040 NW AUSTIN RD RM 221
FORT SILL OK 73503-9043

1 ARMY RSCH LABORATORY – HRED
RDRL HRM AV S MIDDLEBROOKS
91012 STATION AVE
FORT HOOD TX 76544-5073

1 ARMY RSCH LABORATORY – HRED
HUMAN RSRCH AND ENGRNG
DIRCTRT MCOE FIELD ELEMENT
RDRL HRM DW E REDDEN
6450 WAY ST
BLDG 2839 RM 310
FORT BENNING GA 31905-5400

NO. OF
COPIES ORGANIZATION

1 (CD only) ARMY G1
DAPE MR B KNAPP
300 ARMY PENTAGON RM 2C489
WASHINGTON DC 20310-0300

ABERDEEN PROVING GROUND

3 DIR USARL
RDRL HR
L ALLENDER
RDRL HRM
P SAVAGE-KNEPSHIELD
RDRL HRS D
B AMREIN

INTENTIONALLY LEFT BLANK.